Preliminary Exploration and Evaluation of Smart Support for Homeless Community

Yitong Wang
Universal Village Society
Cambridge, USA
ytwangw@gmail.com

Yajun Fang*
Universal Village Society
Cambridge, USA
yjfang@universal-village.org

Abstract—Nowadays, the homeless situation is getting worse especially under the pandemic. The rates of homelessness in the United States have expanded by over 130 percent in just the past two years. Our society has been highly changed and our life quality has significantly improved thanks to technologies like Artificial Intelligence in nearly a decade. However, for people experiencing homelessness, and other such vulnerable groups are under social circumstances lacking humanistic consideration and facing moral issues. Over the past few years, many policies, technologies and approaches have been developed in directions like developing information-collecting platforms, building and classifying emergency shelters and creating robots dedicated to solving comprehensive problems to help people overcome the influences of poverty, illness and unaffordable housing that lead to homelessness, but the actions are never enough because of the partial absence of their focus on user experience, insufficient scope of application and the difficulty of promotion. Under this comprehensive circumstance of the crisis of homelessness, in this paper, we explore homeless status, difficulties and both internal and external challenges with their actual need and various technical solutions. More importantly, we are trying to analyze reasons for not being able to help homeless solve problems and evaluate breakthroughs in application and promotion, summarizing existing technologies and future innovations, proposing possible direction of improvement with a perspective of promoting sustainable development, universal design, and communicative action to help the homeless in various situations.

Keywords—*homelessness, social challenges, smart technology, smart support, artificial intelligence, lifestyle, community, smart humanity, universal village.*

I. INTRODUCTION

Globally, 1.6 billion people live in inadequate housing conditions, with about 15 million forcefully evicted every year, according to the United Nations in 2020 [1]. The whole society should truly confront this huge number and the impact of this population on the world. Due to limited resources, the problem of effectively reducing the number of people experiencing homelessness and properly integrating them into society is a sustainable issue for all developed and developing countries.

The Homeless Hub defines homelessness as an extreme form of poverty characterized by the instability of housing and the inadequacy of income, health care supports, and social supports, including absolutely homeless, shelter dwellers, the "hidden homeless" and others who are described as under-housed or "at risk" of homelessness [2].

There are several causes why homeless occurs, including structural causes or societal causes and personal causes [3].

- Structural Causes: economic recession, unemployment, and lack of good quality, affordable housing including Institutional Causes: People who have lived in foster care and young people leaving care are at high risk of becoming homeless. Also, people leaving prison or mental health institutions with nowhere to go on their release/discharge can end up homeless.
- Personal Causes: poverty, mental illness, learning difficulties, problematic alcohol and drug use, including Relationship Causes: abusive relationship or family breakdown

Moreover, the comprehensive situation, including the tougher economic climate, more unaffordable housing requirements under COVID-19 and the potential for being infected, has led many to become homeless.

Huge damages are occurring to people experiencing homelessness or their impact on society. The mental health issues like depression, psychotic disorder and physical health diseases like tuberculosis, asthma [4] influences their life and further result in a gradually higher mortality rate. According to unhousing statistics in the UK, the number of people dying while experiencing homelessness increased by 80% over the past two years (2020 and 2021) and one death now occurs on average every seven hours [5]. The mental issues sometimes make them less able to integrate into society than normal people even with outside help and they may behave in an anti-social manner. On the other hand, their impacts on society like high crime rates in many communities for a long time, messes on the street, and violence have deeply affected the daily life of human society. These possible behaviors and consequences always make the residents around feel significantly unsafe [6]. The two primary reasons why people are experiencing homelessness are the lack of suitable housing and jobs [7]. Therefore, policies and measures for prevention, intervention and early resolution to homelessness are essential to reduce most people becoming homeless [8].

The homeless population is diverse and there are differences and issues related to age, race, gender, region, etc., which should be paid more attention to and there are a lot of

*Corresponding author

challenges for people experiencing homeless, the people who want to help them and the whole society including financial issues, accessibility to resources and other mixed challenges. This paper reviews the challenges the homeless and society faced and analyses innovations that can help homeless people, especially when considering the inner differences of each group of homeless comprehensively. Because of the rising importance of technologies in the whole world, solving the homelessness problem requires the help of the socio-technical system to address and figure out the difficulties and challenges effectively and sustainably. We will evaluate innovations and technologies trying to find a way to work out the urgent and wide issues related to the homeless and discuss the importance of human impacting factors (lifestyle and community) to the homeless population. More importantly, we want to raise people's concern and attention toward this special group and what everyone can do to help them and propose new proposals and important points for future smart systems designed for people experiencing homelessness to solve homelessness issues effectively.

II. Definition of Homeless

Homeless are people (individual or family) who are living in a temporary place (emergency shelter, transitional housing, or place not meant for human habitation) or are exiting an institution where they temporarily resided if they were in a shelter or a place not meant for human habitation before entering the institution [9].

III. Current Homeless Challenges

This section introduces the challenges brought by the overall homelessness issues faced by people experiencing homelessness and the whole society and discusses specifically divisions of personal challenges and societal challenges.

A. Personal Challenges

This subsection will expand personal challenges using four dimensions, including survival, environment, finance and social challenges.

1) Survival: In America, at least 20 people experiencing homelessness die every day and the total number of deaths increased from 6345 in 2018 to 7877 in 2020 [10]. Younger people are more likely to die according to researchers in many regions and countries [6], [11]. There are four mainstream reasons for their constant high mortality rate in recent years, which are alcohol overuse, drug poisoning, suicide and COVID [11]. Drug poisoning is always the most frequent reason the rate of drug poisoning is nearly twice as high as those among their housed peers [12].

Homeless often struggle with malnutrition because they can hardly ever find nutritionally balanced food or even cannot find food. Relying on generosity from the government, NGOs, family and friends while picking up food waste and unwanted leftovers from restaurant bins is a common food choice for homeless people [13], [14], and the phenomena that these foods have in common is that they are high in fat, low

in fiber, and lack the required daily nutrients and further make an effect on the health situation of people experiencing homeless.In recent years, the availability of cheap, high-energy and nutrient-poor food has changed the condition of the homeless from being primarily underweight to obese [15]. Furthermore, malnutrition affects the health of people experiencing homelessness, especially if they are already in poor health or do not have access to timely and quality medical resources, malnutrition problems such as diabetes and stomach problems can slowly put their lives at risk [4].

Because of these harsh living environments, unhealthy lifestyles and inadequate nutrition, the homeless are more likely to suffer physical and mental diseases. The prevalence of mental issues among homeless groups has a huge difference between countries, varying from 80-95% in the USA, Australia, Canada, Norway, and Germany to 25-33% in Ireland and Spain [4].

In addition, retired people account for a large part of the overall homeless (more than 35%) [16]. They need special attention, especially considering their vulnerability when they have retired and lost their working chances and abilities. According to Professor Margot Kushel who led a research on the homeless, only 16% of homeless own a degree higher than a high school diploma and 63% of people work on physically demanding low-pay jobs in the sample homeless in his project [17]. These groups who do not have enough savings and are more vulnerable and in need of medical resources will greatly increase their possibility of becoming homeless after losing their jobs [17]. It is a tough challenge for these retired elderly populations to reduce the probability of homelessness due to the limited public healthcare and housing resources.

2) Environment: Exposure to the streets or unsuitable conditions because of homelessness, homeless people suffer a lot of environmental challenges, especially the dangers from pollution, weather changes and natural disasters [18] and climate change is increasing the vulnerability of people experiencing homelessness [19].

Pollution including air pollution [20], water pollution [21] and rubbish produces a huge risk for the homeless. They have a higher probability of suffering respiratory diseases, diarrhea, skin diseases, malnutrition and even cancers [21], [22] due to the pollution that occurs everywhere in the environment particularly in the environment where the homeless population used to live like streets, abandoned houses, not well-managed shelters, etc. [23].

Extreme weather brought by climate change like severe cold and excessive heat, will reduce the life quality of the homeless and bring a lot of diseases [24]. Exposure to severe cold subjects homeless people to challenges affecting their survival such as cardiovascular disease, joint damage, frostbite and even frostbitten fingers [25]. Under excessive heatwave, the homeless have a high probability of suffering from heat stroke and skin diseases brought on by prolonged exposure to ultraviolet for a long time because they don't have shelter and air conditioners at that point as a homeless person and they cannot enjoy the comfort in the home. Meanwhile,

homeless people are less able to escape the negative impact of mosquitoes and ticks which appear much more in excessively hot weather [23], [24].

Extreme weather and environmental events displace 20 million people worldwide from their homes each year [25]. They not only make the lives of the homeless people harder but also bring more people to become homeless due to their diminishing tolerance for extreme conditions [25]. These natural disasters like earthquakes, rainstorms, hurricanes, floods and fire destroy the already limited housing supply [23], [26]. However, in post-disaster relief plans, the homeless population is often the least fully considered and cared for [27], [28]. Hurricane Harvey was a devastating storm in Houston in 2017. It wrecked nearly 2,000 Section 8 and public housing units across the state and the homeless population in 2018 has a 13% increase after a year [25]. The wildfires in California in 2018 destroyed 15,000 homes and displaced 50,000 people, but only 10% of the population returned a year after the disaster [23]. How to deal with these challenges brought by extreme weather and natural disasters relating to the survival of the homeless is gradually becoming more serious.

3) Finance: The most direct reason for people becoming homeless is their financial issues [29], [30], [31], and this is the first and foremost challenge they need to face after becoming homeless or finishing homeless experiences. Investment risks [32], sudden death of family members [33], [34], [35], sudden unemployment [32] and illness [35] are some of the main causes of financial issues.

One of the characteristics of financial stress for the homeless population is that it is the most serious challenge [36] for any group of homeless people than any other challenges besides survival because it is hard for them to learn financial management [37] or have a chance to earn money to help themselves overcome homelessness situation as a homeless identity [36]. Financial challenges will also bring long-term impacts. When a homeless family faces issues about financial stress, their kids' sense of happiness will also be influenced and further lead to consequences for kids' growth [38].

4) Social: Statistically, people in families with children make up 30 percent of the homeless population [39]. Among all age ranges, young people have the highest risk of becoming homeless and are often under-estimated. Research shows that the biggest cause of youth homelessness is that they are asked to leave family or leave family by accident [40] and the more exposure to adversity and dangerous situation that young homeless people have to face, the more difficult for them to integrate into the society in the future [41]. Although the youth under homelessness are getting more concerned now due to their future life potentials and developing needs [1], [42], this group of the population suffers heavy mental health problems like emotional damage [43] and these homelessness experiences will highly influence their life [12]. More importantly, experiencing homelessness in childhood will let them lose education opportunities and have a higher risk of being unemployed and losing their living ability [44]. Thus, helping them overcome mental health problems and get into school

are huge challenges and are essential to encourage them to integrate into society, find jobs and get rid of homelessness.

It is a complex challenge for people experiencing homelessness or people who just came out of homelessness to integrate into society because the homeless status makes them more socially isolated [45]. They meet many challenges ranging from social acceptance, their attitude toward integration, dignity issues, interpersonal skills and most importantly, how they can integrate. The experience of being homeless makes people exposes homeless in a stressful environment full of worry about crime, violence, and a scarcity of resources to meet basic needs [46]. Overcoming homelessness often requires the fortification of life skills including social skills including communication, appropriate behavior, and team cooperation, workplace skills including working with technology, and personal skills including hygiene, nutrition, and self-control [47] and they need time and the acceptance from the society to develop these skills trying to live in the society whether as a person experiencing homelessness or as a person who has finished experiencing homelessness step by step. Besides, having a proactive attitude toward finishing homelessness and integrating into society is an important challenge for those people experiencing homelessness because they often lose the desire to rejoin society and develop negative attitudes because of fear of their homeless status and self-abandonment in a state of homelessness for a long time [45].

In addition, the possibility and challenges of homelessness for those with special experiences. For instance, although the homeless will not cause as much crime as the public generally thought, crime is impacting the homeless to some extent because of the barriers of employment and explicit discrimination [48]. According to statistics from the Prison Policy Initiative, those Americans who have been convicted and sent to prison are 13 times more likely to be homeless than others and 15% of incarcerated people experience homelessness in the year before admission to prison [49]. The experience of conviction disrupts people's normal life. Thus they are more likely to become homeless when they get out of prison and weighted the burden of society's reception for them.

B. Societal Challenges

This subsection will expand societal challenges which means the challenges needed to be faced by other people except people experiencing homelessness and the society using six dimensions, including macro management, resources availability and accessibility, healthcare, shelter (housing) and others.

1) Macro Management: Policy and Finance: These kinds of challenges can be separated into different dimensions aiming to help different groups of the homeless population such as breaking education boundaries for children or teenagers, help out for adults to seek jobs, accept them to rent houses and giving them a certain amount of aid.

Homelessness is a structural problem [7], [50], [51], the government should make decisions focusing on prevention difficulties and upstream structural determinants like housing

and financial issues [52]. According to research, Housing First, a policy providing quick housing to people experiencing homelessness aiming to end homelessness proposed in Europe and America has shown its potential to reduce the number of homeless and some aspects of their health issues. However, the long-term health impacts need further investment [53]. The American federal government's evidence-based approach has made progress in recent years, but the shortage of housing is eroding this process [54]. Thus, increasing suitable houses and financial support are much more necessary to help the homeless out of homelessness [55]. The method that the federal government uses to help people experiencing homelessness purchase houses is using the Housing and Urban Development's Housing Choice Voucher (HCV) program [56] by paying the landlords between the affordability of the homeless and the price of housing. HCV has helped appropriate 2.2 million households. However, only one in four eligible families receives the support due to inadequate funding [56].

Public expenditures associated with homelessness are a huge cost and increasing per year. In the United States, estimated costs of a homeless shelter can exceed $7,000 per month per family [57], [58] with additional costs attributed to inpatient hospitalization, incarceration, and public assistance [59], [60].

Education level and the employment rate for people experiencing homelessness are always lower than the whole population [61], [62]. Policies should also consider breaking the education and employment boundaries for people experiencing homelessness. These people have employment barriers including low academic achievement, history of substance abuse, incarceration and spotty work history [63]. Thus, proper policies could help them improve connections between people experiencing homelessness and job opportunities, helping them prepare for applying for jobs, etc. [64]. The biggest challenge for education is how to keep youth experiencing homelessness stay in school instead of dropping out because it is almost impossible to get them back to school [65] due to the displacement occurring during their homelessness period [66]. Therefore, in order to help them get an education, education opportunities and meet basic survival and housing needs should also be carried on simultaneously and comprehensively with employment opportunities instead of only focusing on education singly [65].

Although more policies and programs are needed to help more people experiencing homelessness in various directions, with insufficient funds and resources, policies should consider more prevention to reduce the likelihood of more people becoming homeless. Importantly, policies should ensure the reliable delivery of coordinated prevention and solving problem systems [67]. The United States government has shifted the strategies from helping people experiencing homelessness get out of the crisis to implementing prevention policies [68]. Facing a wide range of demands from people everywhere, how to ensure the accuracy of prevention is a challenge [67], [69]. Specifically, prevention based on different groups of the population and their various situations with evidence-based resources [70], [71] and ensuring that the prevention aims to solve social-determinant factors which make people homeless instead of only solving existing problems [71], [72].

2) Resource Availability and Accessibility: Availability and accessibility to various resources, including the healthcare system, public services, community support and especially technology support is a constant challenge for society to help people experiencing homelessness although the rapid development of the internet helped a lot [73]. Due to the limitation of smart devices, the internet and the lack of social security procedures, it is hard for homeless people getting chances of medical insurance, rental resources, etc., especially the resources that can help them get out of homelessness immediately. Fortunately, accessibility has greatly improved in recent years. 56% of homeless people access the internet once a day and 86% access once a week [74]. There are different apps, websites, policies, etc. that come out for meeting various needs of the homeless like food, shelter, education and public health in order to help them get out of extreme poverty. However, their major challenge has gone from having no resources to how to get reliable and valuable resources because the complexity of the internet makes it often too high a threshold for these people to pass [73]. Moreover, although apps, websites and other ways to get information are more and more abundant, their user-friendliness still needs improvement continually including how to let people find the information they need most and how to guide them in finding resources by themselves quickly [73].

Besides internet accessibility, when facing limited available resources, the number of homeless is more than the shelters, beds and food most of the time. It is difficult to arrange for every homeless individual due to the limited resources while bringing out concerns by others toward the gathering of the homeless. For instance, LinkNYC [75] is a communication network located as kiosks in New York city attracting many homeless people to interact with it all the time. Sometimes when too many homeless people congregate there it causes a lot of noise and they become more and more preferable to live in the neighborhood because of the convenience of the kiosks thus the whole neighborhood is congested with too many homeless people and disturbs nearby residents. The major problem is the lack of resources, like these kiosks [75].

3) Healthcare: The homeless are more susceptible to various diseases, especially infectious diseases like respiratory diseases and chronic diseases like high blood pressure and diabetes [4] and finally lead to high morbidity and mortality because of their constant exposure to the natural environment and unhealthy food and water [15], [76]. This, coupled with the fact that medical resources are in most cases inadequate and inaccessible, makes staying healthy and getting treatment as soon as possible after an illness is a long-term challenge for the whole society, especially in this post-pandemic period [76]. Since the prevalence of diseases is much higher in the homeless population than in the general population, it is important to improve the access of people who are homeless to health care services to reduce diseases-related morbidity and

mortality [77]. Under this situation, housing is more likely a primary foundation for society to solve multi-healthcare challenges [76], [78].

When considering the reality of the situation, our society should deal with these challenges using integrated methods combining in-time intervention including resources supply and necessary consultation structure and comprehensive health-related prevention [79].

4) Shelter (Housing) : Poor people are more likely to use more money renting houses (appropriately more than 40% of their income in Europe and 30% in America) [67], [80] , which may lead to the situation that they suffer from housing pressure and instability while having a certain lack of funds in other things. However, according to research, the homeless spent 50% of their income on housing, approximately $183 a month at that time, while only one-fifth of housing was under $200 a month [68]. This high-cost number in housing makes people experiencing homelessness compress in other living expenses like food or medical while the risk of losing houses is really high too.

Both stable housing and temporary shelter are all urgent needs for people experiencing homelessness during this economic and political crisis in recent years. However, the financial cost and management costs are challenges for society to keep helping and supporting people experiencing homelessness and ending homelessness using the housing.

The Canadian government spends tens of thousands of dollars each year on shelter construction and subsidies for the homeless and deals with the subsequent development of environmental and mess issues. Due to COVID-19, the cost will be much higher and the risks will grow. According to research in Toronto, the average cost of operating a single shelter bed is $40,000 a year, and that number has nearly doubled during the pandemic [81].

A phenomenon that may not be too mainstream is that sometimes the homeless prefer to live on the street over in the shelter because there are unknown dangers like drugs and drug dealers and bedbugs and body lice exist in some shelters [82]. Thus, providing adequate resources and a reliable management system is equally as challenging as building enough shelters.

5) Others: To face all those challenges above, the government or the society is also struggling with human resources, burdens and many complex issues.

C. Summary

The challenges related to the homeless are multifaceted and thus require multifaceted considerations and a combination of actions, policies, and approaches to solve the problem. Humanity factors, especially social inclusion should also be emphasized.

IV. EVALUATION OF CURRENT TECHNOLOGIES

This section evaluates current technologies including typical methods and new technologies in helping and supporting people experiencing homelessness in terms of four major factors in the feedback control loop.

A. Sensing

Society will face two crucial problems: where are the homeless and who are the homeless if they want to end homelessness. Facing the problem of how to find the homeless, many use machine learning models and optimization techniques to locate, detect and target them [83], [84], [85]. Specifically to the dwelling status, unavailable data increases the difficulty of locating machines to find the homeless and the various situations of different people experiencing homelessness resulting in different characteristics also cause problems of distinction during the process of training a model and applying it [86]. Recent research using deep learning and synthetic techniques like convolutional neural network (CNN) and generative adversarial network (GAN) extract features of known realistic temporary tents and housing of the homeless images even in relatively small data sets instead of assumptions and then identify new images using these characteristic results [86] which could allow a lot for people to know where are the homeless and make specialized policies and services to help them considering the geographic differences.

Public cameras play an important role in monitoring the status of people experiencing homelessness in the city.

For these homeless who already live in shelters, they face healthcare issues and drug overuse when living in such poor conditions [87]. Thus, monitoring their living status is important. Leonardo Queiroz et al. [88] proposed an approach to monitoring the living pattern and measuring the breathing rate in sleep time for the homeless living in shelters which helps shelter staff manage the living status of the homeless.

B. Communication

One characteristic of people experiencing homelessness is that they are usually socially disconnected from the community and find it hard to integrate into society. Information is usually available in face-to-face status [89], [90], but providing online information is a necessary way to promote the availability. Nowadays, numerous apps, websites, platforms, etc. are designed to meet the increasing need of people experiencing homelessness. To address this specific technology user group, a comprehensive broader socio-technical system [91] is desired and needs to be approached sensitively.

Technologies provide an important role in connecting people experiencing homelessness with others and society [92], [93]. Besides the accessibility and availability difficulties that society has already realized [94], many problems are getting more concern and attention. Research has developed to these questions ranging from information overload [95], whether the information is reliable or not, the emotional support from the communication technologies [96], whether these specific users feel connected and cared for or not [97], [98], [99], what are the real needs from this population [91]. Rachel Burrows et al. [91] provided a comprehensive summary of these aspects and confirmed the importance of the authenticity of the well-selected information and the match with the real need for the homeless while making information ubiquitous is not the solution [100].

When discussing the information people experiencing homelessness received, the difficulties of accessibility have significantly decreased because of the popularization of the internet and smart devices although they are experiencing homelessness [101]. The major problem they are facing now is finding useful information online or offline [73]. Thus, providing a user-friendly app or website that meets the specific needs of the homeless with a lower threshold is what many governments and academics are doing and trying to achieve in recent times.

Rachel Burrows et al. [91] explored people's attitudes especially in emotional aspects toward Ask Izzy, a mobile web app designed for the homeless to find services they need, through interviews with participants including the app developer, the homeless and the ex-homeless. They found that Ask Izzy reduces the control from service provider to app users while providing, the homeless usually trust others who have the same situation which provides recommendation as to what app is more reliable, friendliness of service providers is important, etc. Especially that they found the services which Ask Izzy offers are not only provided by "service providers" but also the people who are also experiencing homelessness or ex-homelessness which means that they have many experiences to share, and this type of platform is really an important and necessary breaking point for the homeless communication.

An action research has been done by Marc Hegeman [73] aiming to answer the question that how a digital application is designed to provide reliable and up-to-date information for the homeless points out that understanding the specific needs of the target group before undertaking any design and development, ongoing operation and getting sustainable feedback are really important. They summarized five principles when giving a design of service to the homeless, which are putting the user first, never being satisfied until users are satisfied, making things easy, proceeding based on facts instead of assumptions and being transparent. These are almost the perfect principles that most homelessness communication designs need to consider.

Carlbandro Edoga [102] proposed an app providing position information for the homeless aiming to address design and usability issues. This app has a huge influence on mitigating their social exclusion, empowering them to independently acquire information and promoting their (re-)socialization. They used natural language processing in order to confer the app dynamic and persistence, answering two major questions about app data "How can the entirety and accuracy of the information be technically realized?" and "How can this process be repeatedly improved to make it more accurate and more sustainable?". Meanwhile, they pointed out that information platforms like the application they proposed have common limitations, such as the heavy reliance on Google data without critical accuracy examination, narrowing of languages other than English, ignorance of compound words when searching, etc.

In summary, any communication systems, including any mobile services (apps, websites, channels), physical and offline forms and information flow in the homeless communities need to consider increasing accessibility, experiencing sharing and transparency, ensuring the entirety and accuracy of all information and make things easy in order to really help people experiencing homelessness.
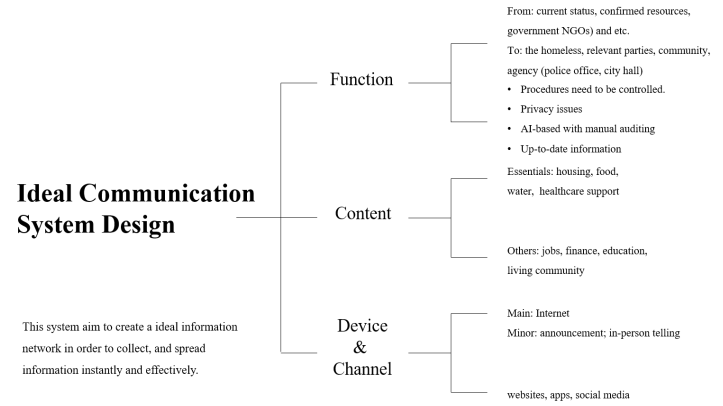

Fig. 1. Communication System

C. Decision Making

Technologies and artificial intelligence often play important roles in information optimization and multi-task management when people apply them to helping the homeless.

There are several breakthroughs in how to solve shelter and housing issues among people under homelessness. Pedram Khayyatkhoshnevis et al. [85] discovered that low-cost web platforms can be used to promote homeless-housing matching more effectively and accurately and they introduced eight no el heuristic algorithms creating ideal allocation for the homeless to shelters. The implication of such an algorithm is that it allows homeless people to be matched with resources more quickly according to their situation and needs and allows decision-makers (governments, organizations) to understand how best to provide resources. Malik Ayush [103] proposed a machine learning solution using Neural Network Models and Time-Stamped data record to identify, classify and predict chronic homeless in shorter time accurately with high precision and high f1-score. Afton Jackson and Lisa Shannon [104] proposed multi-task learning techniques which have used as the standard approach for complex applications when the model is trained to solve multiple tasks simultaneously in order to improve the performance, reduce inference time and computational complexities. These techniques can collect and process high amounts of information and thus can provide comprehensive decision making advice about helping the homeless.

There are various breakthroughs in providing services and operational resources. Michael Businelle et al. [105] used ecological momentary assessment (EMA) to develop a just-in-time adaptive algorithm intervention determining risk moments and factors to provide people experiencing homelessness drinking and deliver treatment messages. Specifically, EMA is used to examine every time's relationship between

social cognitive theory constructs, social-ecological model constructs and drinking according to participants' self-report in the experiment while geolocation and psychosocial data are inputs in assessment. Divya Ravikumar et al. [14] investigate impacting factors when economically disadvantaged families (including the homeless) make food decisions. This research pointed out that food cost is the most influential factor influencing family's food decision and the economic situation and high cost of high-nutrition food make negative impacts on dietary intake and quality for people experiencing homelessness. David Hendry et al. [64] proposed a sociotechnical system focus on addressing identity challenge and job challenge faced by the homeless which has a main goal to provide them information about possible jobs and help them escape homelessness situation. The matching system (Job Co-op) they developed connects homeless young people with job and job providers one by one successfully, which is a great innovation for helping young people experiencing homelessness changing life status. They invited young people to participate in community development and promoted Job Co-op widely. Erin Fletcher [106] explored and researched smart practices for young homeless people in Metro Vancouver finding jobs and reemployment strategies. They found that social exclusion and integration difficulties making hard for young homeless people find jobs and highlighted a significant policy proposed by the Employment Program of British Columbia (one stop-employment program) which makes various kinds of programs and services combined into a single program delivery model. After meeting with representatives from young employment organizations in Metro Vancouver, they advised five smart practices: developing a comprehensive program, meeting personal and specific needs, strengthening the connection between homeless young people and job providers, extending the standard of program outcome and attracting more potential employers.

D. Action

Various applications have been used for helping people experiencing homelessness to face their needs including the basics, living status, etc. The most important is that any actions and technologies should consider human-centered needs at the forefront.

In the healthcare field, David Bellamy et al. [107] identified a medical machine learning benchmark assessing progress on four clinical prediction tests which allowed the first direct comparison of predictive performance. Inspired by the medical benchmark's development, we believe that there should also be an existing benchmark in medical examination and health status analyzation to implement standards for actions for people experiencing homelessness in shelters or hospitals, which may reduce the percentage of the occurrence of infectious diseases and improve the overall physical fitness of this population. Imrus Salehin et al. [108] evaluated the influences on people's mental health behaviors under COVID-19, they found that homelessness is indeed a huge impact factor in changing people's mental health situation especially under the pandemic.

V. Human Impacting Factors: Lifestyle and Community

Lifestyle and Community are two major human impacting factors of UV, especially when considering their importance to homeless people [109]. This section elaborates on the interactions between these two factors and homeless and their specific impacts.

A. Lifestyle

UV lifestyle is defined as a function that takes an individual's genes, current status and surroundings as independent variables and outputs a prediction of someone's future as dependent variables to quantify [109].

In order to apply lifestyle variables (individual's genes, current status and surroundings) specifically for the homeless community, we adjust them to personal information (people's age, nations, family status, etc.), living status (employment, housing and health) and environment (surrounding community, natural environment, etc.).

These three categories of variables highly determine the lifestyle of people experiencing homelessness. People who experienced homelessness may have trauma when in a family associated with the loss of home, and these unrecognized and unaddressed traumas can have potentially devastating implications for development across people's lifespan [110]. Homeless people who stay in cold weather are more likely to care about how to survive in a snowstorm than those who stay in warm places. Examples above indicate how variables affect someone's status and their future lifestyle.

B. Community

Based on UV concepts, seven kinds of communities bring people together which are applicable in the homeless community too, including interests, initiatives, geography, experiences, devices, nature and profession [109]. More specifically, we believe that these community notions more clearly reflect in people experiencing homelessness, especially when also considering virtual community and belongingness. According to the same interests and staying areas, the homeless gradually form groups, in which they exchange information with each other in these small groups.

There are also various virtual communities in the homeless population. Now that many apps and websites appear to provide resources for people experiencing homelessness, they can also play a role in solidifying their users as a community.

In the special COVID situation, community-based united is an ideal unit for the homeless to consolidate together against this dilemma and fight for shelter and healthcare resources [111].

VI. Interaction and Coordination with Other UV Subsystems

Universal Village is a newly proposed concept exemplifying an ideal future society that addresses the current challenges cities are facing in the process of development and pursues harmony between humans and nature through the wise use of

technologies There are eight subsystems in Universal Village including Smart Home, Smart Medicine and Healthcare, Smart Humanity, Smart Energy Management, ITS, Smart Infrastructure, Smart Environmental Protection and Smart Response System for City Emergency, is developed based on the essence of humanity: Survival and Life, Equality and Respect, Service and Sharing, Happiness and Health.

Smart subsystems of Smart Cities, such as Smart Humanity, can not perform their designated functions properly alone. There are interactions between all these subsystems. Subsystems have both positive and negative impacts on each other. To achieve coordinated and systematic optimization, it is important to consider these interactions during the design and operation phases of all the subsystems.

Specifically, in the scope of this paper, the interaction between the homeless, an important part of Smart Humanity and the other seven subsystems of smart cities is discussed based on the essence of humanity (Survival and Life, Equality and Respect, Services and Sharing and Happiness and Health) [109].

A. Smart Home

Smart Home is intended to improve house automation. Specifically for the homeless population, it can provide a variety of chances and services to help people experiencing homelessness improve their life circumstances and even stop their homelessness completely.

1) Survival and Life: Smart Home plays an essential and crucial role in meeting the basic need for the homeless's survival and guaranteeing safety and security in life.

2) Equality and Respect: Smart Home collects information about different homeless populations from different areas and religions, with their previous status before experiencing homelessness. For diverse groups of homeless populations, their various beliefs can be respected during the process of housing or job seeking.

Most current home systems focus more on the expansion of numerous features but ignore the difficulties to operate for vulnerable populations. Interacting with Smart Humanity for homeless people, Smart Home Devices should be equipped with easy-to-use mechanical switches and controls [112].

3) Service and Sharing: Smart Home enables sufficient customized and personalized information and services for people experiencing homelessness. Moreover, Smart Home promotes more shelters, jobs and community support for people experiencing homelessness to integrate into society while giving solutions on how to improve resources' availability and accessibility to the homeless population.

4) Happiness and Health: Smart Home processes inner differences between different homeless populations especially their cultural differences and respects diversity between various homeless communities. Smart Home subsystem also cooperates with Smart Healthcare to ensure the statistics and evaluations of the health status quo of inner-shelter homeless and fixed homeless communities in areas.

B. Smart Medicine and Healthcare

Smart Healthcare aims to provide timely, efficient and effective medical service in smart cities [113]. It can guide how people experiencing homelessness use healthcare resources and how healthcare provides help to the homeless effectively and makes healthcare opportunities more accessible.

1) Survival and Life: The homeless almost have the worst physical condition in the entire society due to the lack of food, the effects of the climate, the lack of medical treatment, the lack of access to medical care, etc. Globally, there are life expectancy gaps of more than 30 years between housed people and the homeless populations [114] [115] [116]. The healthcare system of society as a whole is not able to guarantee access and health for everyone, especially for this specific group, the homeless, and in the situation of COVID. Thus, enlarging the capacity of the healthcare system using techniques, smart devices and supports are necessary.

2) Equality and Respect: Smart Healthcare needs to ensure safety, standardized design and evaluation frameworks of the medicine process for the whole society. Equally, the health issues of the homeless population also need attention. Government and Smart Healthcare design should jointly promote the development of smart technologies involvement in the healthcare system to reduce access time while increasing efficiency of assistance.

3) Service and Sharing: Smart Healthcare provides necessary health support for the homeless population, especially in the prevention of diseases. The complete smart healthcare system can prevent homeless diseases and solve them more efficiently and quickly without using excessive medical resources. More importantly, Smart Healthcare design can personalize services for people experiencing homelessness to ensure they have appropriate treatment.

4) Happiness and Health: The focus on prevention and personalized treatment in the Smart Healthcare design will help the homeless maintain a healthier state of health and help them integrate into society and escape from homelessness.

C. Smart Energy Management

Smart Energy is essential to people's survival especially for vulnerable groups in how to design personalized assistance for those who are in trouble. It provides guidance on energy issues for people experiencing homelessness effectively [117].

1) Survival and Life: Various problems are emerging from energy-insecure appliances and the behavior of homeless people. For example, if they don't have enough money to buy safety compliance heaters, thus the insecure heater may lead to fires. During extreme weather, especially extreme hot and severe cold, homeless survival meets challenges. In these situations, Smart Energy design can play a role in adjusting energy resource distribution (heaters, air conditions, etc.) in major areas where homeless communities usually exist.

2) Equality and Respect: Income inequality leads to different levels of energy use. In Smart Energy Management design, it is necessary to balance the use of energy in different areas effectively using smart designs.

3) Service and Sharing: Smart Energy Management should consider the special needs of vulnerable people. For example, it is common that the homeless people don't have the money or opportunity to buy air conditioners, fans, etc. to make themselves healthier in extreme weather. Therefore, inexpensive and efficient smart devices will highly change their life and reduce the probability of getting diseases or unhealthy situations.

4) Happiness and Health: The design of Smart Energy Management can control the use of energy effectively, ensuring that energies are used in the right place, which will actually increase the happiness of people experiencing homelessness especially when they have the accessibility of energy resources thanks to better allocations.

D. ITS, Urban Planning and Crowd Management

ITS, Urban Planning and Crowd Management aims to manage the city transportation system and improve the safety, capacity and automation level of city transport [118]. As an important part of the city, the public transportation system is the major travel tool the homeless people use, especially bus and subway.

1) Survival and Life: As a group of people who have lost their homes, the majority of the homeless live on the streets, which means that their lives are at risk from accidents and public disorder on the streets. In the scope of ITS and Urban Planning system, streets policing could be better managed, and Crowd Management may work out the problem of community safety due to the overcrowding caused by the homeless.

2) Equality and Respect: ITS, Urban Planning and Crowd Management control the allocation of public transportation and regulate public resources' between regions. Considering the traveling needs of the homeless community and the fact that some of them are located in more remote areas, ITS should enlarge the coverage areas by public transport for the convenience of everyone in the city.

3) Service and Sharing: A survey investigated the homeless sleeping overnight on buses in Northern California's Santa Clara County. They found that two-thirds of the participants live on buses all day (24 hours) which is their only "shelter" [119]. When the number of homeless people exceeds the capacity of the public transport system, the ITS system has to both limit the homeless (due to their disturbance of public order and the creation of unruly behaviors) and take on the responsibility of expanding the capacity and coverage areas while strengthening the openness of the public transport system in order to assist the homeless.

4) Happiness and Health: In the ITS system, traffic accidents generate the majority of the health difficulties of people experiencing homelessness. According to a survey taken of Turkish homeless patients who were brought to the emergency department by ambulance, traffic accidents are proved to be the most common reason among all trauma cases, which is nearly one-third among all 21.56% of trauma cases patients [120]. To address this fatal impact, the ITS system should establish a more strict transportation system and enhance traffic safety management.

E. Smart Infrastructure

Smart Infrastructure, as the most fundamental and essential coordinated services of all functional subsystems [121], is very important for the basic survival of the homeless population. Public infrastructure including shelters, public toilets, squares and subway stations are places where the homeless are always found. Problems cover the unavailability of public toilets, the concentration of homeless people in certain metro stations and the overcrowding of homeless people in certain neighborhoods are all issues that need to be addressed by public infrastructure design.

1) Survival and Life: The survival of people experiencing homelessness highly depends on cities' or communities' infrastructures: streets, shelters, public toilets, bus and subway stations, etc.

2) Equality and Respect: Public opinion needs to be considered. Therefore, the coordination of Smart Infrastructure design and Smart Humanity concepts is necessary for building a positive fusion of the homeless community and society. In a case, fixmystreet [122] is an app that citizens in Brussels, Dutch report incidents of disorder in urban public spaces to the local government. Lior Volinz (the author) [122] found out that the homeless population's belongings in the street are always mistaken for rubbish and the city has to clean them up because these things highly influence city's appearance.

3) Service and Sharing: Cooperating with the ITS system, Smart Infrastructure needs to manage the resources allocation of public infrastructure, especially in public transportation systems. Specifically to the gathering of the homeless population in particular areas, they have to reallocate and manage shelters, restaurants, bus stations, etc. Moreover, Smart Infrastructure leads the cooperation of almost every subsystem assisting the homeless population, including city policies' setting, smart robots in infrastructures, shelters maintained and transportation designs.

4) Happiness and Health: Some Smart Infrastructure designs can provide relaxation for homeless communities. For instance, some communication network kiosks proposed in NYC [75], a special form of Smart City Infrastructure that serves as the place where the homeless people can access to the internet and do entertainment staffs like listening to music. Although the concern of these kiosks, gathering around of the homeless people, noise complement by nearby citizens, etc, truly need to be solved, it provides an innovative idea of Smart Infrastructure.

F. Smart Environmental Protection

Smart Environmental Protection is dedicated to maintaining the sustainability of smart cities and human-nature harmony [123].

1) Survival and Life: The biggest problem in environmental protection is that the homeless group is extremely insensitive to hygiene, thus the messes they brought would highly impact

natural ecology and urban pollution. Thus, the less clean environments they create and live in will be a nuisance to their health.

2) Equality and Respect: In Smart Environmental Protection designs, people need to respect each other especially between and in the homeless communities, making conscientious maintenance of their own neighborhood and not affecting the environment of other neighborhoods.

3) Service and Sharing: How to deal with the environmental and urban impacts brought about by homeless street sleepers is a joint effort of government and organization, and is a joint issue of environmental protection and humanity. Some "smart" applications can be considered in service like the intelligent environmental detector that can alert to pollution levels in the environment.

4) Happiness and Health: A clean and aesthetically pleasing environment is beneficial to one's enjoyment of life. Environmental Protection is an issue that all people need to be concerned about and make efforts to contribute to the betterment of our world.

G. Smart Response Systems for City Emergencies

Smart Response System is designed for detecting emergencies and executing corresponding measures to eliminate and avoid casualties and property losses [124].

1) Survival and Life: The biggest emergency crisis affecting homeless people in recent years has been the difficulty of surviving under widespread COVID. Since low immunity due to lack of influence and lack of adequate access to medical care, people experiencing homelessness are hard to survive in COVID crisis and even their already slow trend towards a better quality of life will be broken [111].

2) Equality and Respect: In emergencies, vulnerable groups like the homeless need equal protection and respect, especially in healthcare resources, shelters, etc. The distribution of resources and shelters needs to be considered and allocated equally in different areas.

3) Service and Sharing: Smart Response designs are meaningful in many inconspicuous but important points: antigens and drugs for combating the sudden onset of COVID, emergence kits in case of an earthquake, etc. The basic objects can sometimes save one life, especially in times of lack of resources faced by people experiencing homelessness.

4) Happiness and Health: Post-emergencies development will help those who have been rendered homeless by the disaster to develop their psychological confidence and thus motivate them to get out of the homeless situation.

VII. PRELIMINARY PROPOSALS

This section proposes some preliminary proposals and important points for the development of future smart systems designed for people experiencing homelessness based on the challenges of the homeless and innovations in helping and supporting homeless people through different perspectives:

- Homelessness is a comprehensive issue that should have more sociological, psychological, ethical and political considerations added to it, making the humanity aspect involved can help a lot in letting people experiencing homelessness truly try to participate in social work and integrate into society.

- Based on the circumstances in which homelessness occurs and the definition [3], [52], [76], whatever the factor behind it, the immediate cause is the lack of housing, and therefore we believes housing always comes first.

- Although developing a comprehensive system is necessary, categorizing people experiencing homelessness for help is much more important. The government, NGOs and anyone else who wants to help people experiencing homelessness can offer different kinds of help to different categories of homeless people in a differentiated way. For example, homeless people with certain skills can be matched with jobs more quickly while people who have underlying medical conditions can receive shelter with basic medical staff rather than normal shelters.

- The connection of delivery of homeless assistance is also necessary. Organizations and groups need chances to communicate and collaborate to face homelessness challenges and provide assistance for homeless people together. By monitoring dynamic data and real-time different homelessness statuses, they have to constantly adjust and modify the original plan to meet the new needs, making the assistance more flexible.

- With the widespread availability of the Internet today, online information exchange and help platforms are gradually replacing a few offline approaches because of efficiency and universality. However, information delays frequently appeared on most platforms.

- Education resources are always important. If housing is the most direct way of getting homeless people out of the homelessness situation, then education is the most important way of preventing people from becoming homeless and getting homeless people out of a disadvantageous situation altogether although not a remarkable step up in class.

- Prevention policies are significant since the cost of helping homeless people get out of homelessness situation is much higher than making progress in prevention while it is far more difficult to change the status quo than to prevent such a bad situation from arising (according to many cases).

We believe that to achieve "reducing the likelihood of people becoming homeless and allowing homeless people to integrate more closely into society or not be homeless at all," reasonable intervention and comprehensive and integrated intervention and help complemented by technology and innovation.

VIII. CONCLUSION

Solving problems related to homelessness entirely is always complex and difficult, whether in terms of sociology or technologies. Thus, we are trying to explore multiple reasons and possible solutions to help the homeless population in

this paper. We summarized and evaluated the current situation and challenges and smart support for homeless society, including personal challenges faced by homeless communities and individuals (survival, environmental, financial and social challenges) and society challenges faced by everyone in the society especially governments, NGOs and any organizations and groups related to the homeless. We found that not catering to the experience of the homeless communities is a common phenomenon among all system designs, apps and websites, which makes it the biggest challenge to match the need of this vulnerable group and resources. To improve that, specific and personalized designs are also useful and necessary. We hope to raise people's concern about the homeless society, what can we do to help them and how smart support plays a role in helping vulnerable groups.

Based on preliminary exploration, we found that research achievements that have been made so far are still at a preliminary level in different perspectives, in which most of them are focused on improvements and innovations in technologies due to the difficulty of applying well in the combination with smart upgrades.

In the future, we hope to keep further evaluation of smart support for homeless society and investigate more innovative interaction between different systems and the homeless issue explore the possible integration of humanity consideration and smart innovations, especially in the quantitative investigation: how specific factors influence the homeless situation and how different aspects can help them in what extent.

Acknowledgment

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